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(54) Breathing apparatus.

(57) A positive pressure filter respirator includes a full face mask comprising an outer mask 1 and an inner orinasal mask 2. A filter canister 5 is screw mounted to an air inlet 4, and a centrifugal fan 6, which is driven by a battery operated motor 7, is so arranged as to draw air through the filter canister 5 into the outer mask 1. The filter life and the battery life are extended by the use of a pressure responsive means which responds to the difference in pressure between the pressure in the interior of the orinasal mask 2 and the pressure in the space 20 within the outer mask 1 and outside the orinasal mask 2. The pressure responsive means reacts immediately to the commencement of either exhalation or inhalation to disable the fan 6 on commencement of exhalation and to accelerate the fan 6 on commencement of inhalation. The pressure responsive means comprises a diaphragm 9 and an infrared proximity detector 10 mounted close to the diaphragm 9, and, as described, the pressure responsive means acts to switch off the fan 6 at the commencement of exhalation and to switch the fan 6 on at commencement of inhalation.

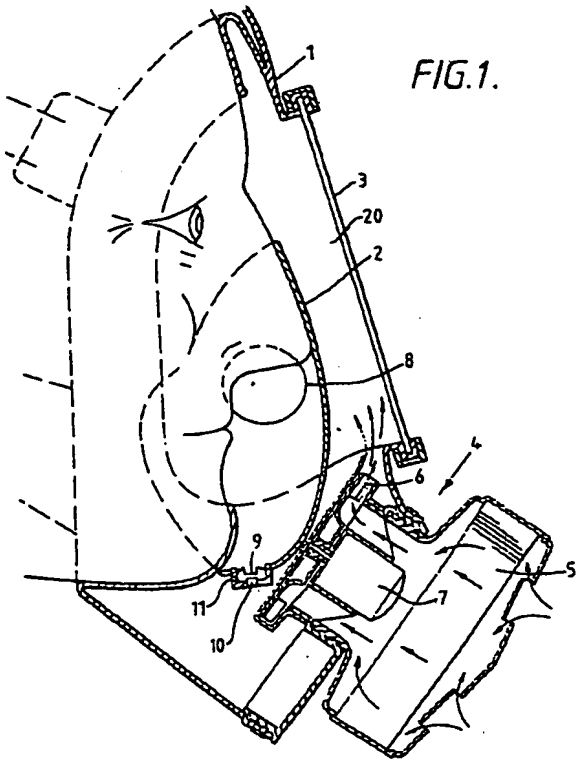

FIG.1.

EP 0 334 555 A2

risking the entry of toxic gas into the outer mask from which breathing gas is taken into the inner mask.

In breathing apparatus according to the present invention the fan is switched on at the commencement of the inhalation period of the breathing cycle without placing a significant physiological burden on the wearer.

Breathing apparatus in accordance with the present invention provides a high degree of protection, as a result of positive pressure, for a longer period than the known conventional positive pressure respirators without having recourse to larger or more expensive components, and such breathing apparatus is very advantageous in circumstances where a continuous high flow of air is not required.

The present invention will be further understood from the following detailed description of a preferred embodiment thereof which is made, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a cross-sectional side view of a positive pressure filter respirator incorporating the present invention, and

Figure 2 is a diagrammatic representation of an electrical circuit for use in the embodiment of the invention illustrated in Figure 1.

Referring to Figure 1 there is shown a positive pressure filter respirator which includes a full face mask comprising an outer mask 1 and an inner orinasal mask 2 surrounding the respiratory passages of a wearer.

The outer mask 1 includes a visor 3 and an air inlet generally designated 4 to which a filter canister 5 is screw-mounted. Immediately within the filter canister 5 there is located a centrifugal fan 6 which is arranged to be driven by a battery-operated motor 7 so as to draw air through the filter canister 5 and into the interior of the outer mask 1.

In operation the fan 6 draws air through the filter canister 5 at a rate greater than the rate of leakage of gas from the full face mask so that a positive pressure above the pressure of the ambient atmosphere is maintained within the outer mask 1.

Mounted on opposite sides of the orinasal mask 2 are an inhale valve 8 and an exhale valve which is not shown in Figure 1 but which is in a similar position to the inhale valve 8 on the opposite side of the orinasal mask 2 to the inhale valve 8. However, the inhale valve 8 connects the interior of the inner orinasal mask 2 to the space 20 within the outer mask 1, whereas the exhale valve connects the interior of the orinasal mask 2 direct to the ambient atmosphere outside the outer mask 1.

There is also provided within the orinasal mask 2 a pressure sensing diaphragm 9 which is mounted close to a solid state infra-red proximity detector 10 so that the pressure sensing diaphragm 9 moves relative to the proximity detector 10 in accordance with the difference between the gas pressure within the inner orinasal mask 2 and the gas pressure in the space 20 within the outer mask 1, an aperture 11 in the body of the orinasal mask 2 on the underside of the diaphragm 9 communicating with the space 20 within the outer mask 1 but outside the orinasal mask 2.

The output from the proximity detector 10 is used by a circuit which will be described with reference to Figure 2 in order to disable the fan motor 7 when the gas pressure within the orinasal mask 2 rises relative to the gas pressure in the space 20 as the wearer exhales.

In consequence the fan motor 7 is switched off during the exhale period of the breathing cycle and remains off during the rest period of the breathing cycle until the next inhalation period, thereby substantially reducing the average flow rate of breathing air and increasing the life of the battery and the filter by a corresponding amount.

In Figure 2 there is shown the electrical circuit incorporated in the positive pressure filter respirator of Figure 1. The solid state infra-red proximity detector 10 comprises the diode 12 and the infra-red responsive transistor 13, the voltage across the transistor 13 increasing as the infra-red radiation received by the transistor 13 increases in consequence of the approach of the diaphragm 9 to the transistor 13.

A proportion of the voltage developed across the transistor 13 is selected by the adjuster 14 and compared with a standard voltage by a voltage comparator 15. The proportion of the voltage across the transistor 13 which is selected is advantageously chosen such that the voltage comparator 15 gives an output to energise the relay coil 16 and disable the fan motor 7 when the gas pressure within the orinasal mask 2 is positive due to exhalation, i.e. greater than the gas pressure in the space 20 within the outer mask 1.

The operation of the invention in the positive pressure filter respirator illustrated in Figure 1 will now be described in relation to the circuit of Figure 2.

When the wearer starts to inhale, the relative pressure drops, that is to say the gas pressure within the orinasal mask 2 falls below the gas pressure in the space 20 outside the orinasal mask 2 but within the outer mask 1. This drop in relative pressure causes the fan 6 to be immediately switched on, thereby sucking an excess of air into the space 20 within the outer mask 1. The gas pressure in the space 20 is thus increased relative

to the gas pressure in the orinasal mask 2 with the result that the inhale valve 8 opens allowing clean filtered air to enter the orinasal mask 2 and the respiratory passages of the wearer.

When the wearer exhales, the gas pressure within the orinasal mask 2 rises relative to the gas pressure in space 20 and the inhale valve 8 closes. This increase in the relative gas pressure is detected as a result of movement of the diaphragm 9 towards the infra-red proximity detector 10 with the result that the fan 6 is switched off, thereby allowing the positive pressure in the space 20 relative to the pressure of the ambient atmosphere to vent to atmosphere through the filter 5. Also the excess pressure within the orinasal mask 2 causes the exhale valve (not shown) to open and allow the exhaled gases to be vented from the orinasal mask 2 direct to atmosphere.

Apart from a momentary pressure at the commencement of inhalation, there will always be a positive pressure within the inner orinasal mask 2 in positive pressure breathing apparatus according to the present invention. The pressure in the space 20 within the outer mask 1 but outside the orinasal mask 2 will be positive during inhalation, but will fall to ambient pressure during the exhalation period and the rest period of the breathing cycle.

In breathing apparatus which includes both inner and outer masks, the positive pressure breathing apparatus of the present invention is unique in providing for increase in the life of the filter by disabling the air mover in response to detection of an increase in the difference between the pressures in the inner and outer masks as a result of exhalation. It is the increased pressure of gas provided within the confined space of the inner mask as the wearer commences to exhale which causes the air mover to be switched off, giving a swift response and substantial increases in both filter life and battery life.

The positive pressure breathing apparatus according to the present invention has the further advantage over positive pressure breathing apparatus in which the air mover is controlled as a result of sensing a change in the pressure present in the space between the air mover and the filter that the effort required to cause the fan to switch on when inhalation commences is substantially less and there is therefore a much smaller physiological burden placed on the wearer by the apparatus of the present invention. This is in addition to the faster response to the commencement of the inhale part of the breathing cycle.

Claims

1. Breathing apparatus for excluding noxious atmospheric gases from the respiratory passages of a wearer, the breathing apparatus comprising:
a) an outer member (1),
b) an orinasal mask (2) located within the outer member (1),
c) an inhale valve (8) mounted in the orinasal mask (2) and operable to connect the interior of the orinasal mask (2) with the space (20) within the outer member (1) and outside the orinasal mask (2),
d) an exhale valve mounted in the orinasal mask (2) and operable to connect the interior of the orinasal mask (2) direct to the ambient atmosphere,
e) an air inlet (4) to the outer member (1),
f) a filter (5) mounted in the air inlet (4),
g) air moving means (6) for moving air through the filter (5) into the outer member (1) to establish a pressure above ambient pressure within the outer member (1) and outside the orinasal mask (2), and
h) a power source (7) for driving the air moving means (6),
characterised in that there is provided:
i) pressure responsive means (9, 10) responsive to the pressure difference between the pressure in the interior of the orinasal mask (2) and the pressure in the space (20) within the outer member (1) and outside the orinasal mask (2) for causing the power source (7) to disable the air moving means (6) at the commencement of an exhale period in a breathing cycle and to accelerate the air moving means (6) at the commencement of an inhale period in the breathing cycle.

2. Breathing apparatus according to Claim 1 characterised in that the outer member (1) is a flexible hood.

3. Breathing apparatus according to Claim 1 characterised in that the outer member (1) is a full face mask.

4. Breathing apparatus according to any one of Claims 1 to 3 characterised in that the pressure responsive means comprises:

a) a diaphragm (9) mounted within the orinasal mask (2),

b) an infra-red detector (10) mounted to the orinasal mask (2) in the proximity of the diaphragm (9), the infra-red detector (10) giving an output dependent on the position adopted by the diaphragm (9) under the said pressure difference, and

c) control means (14, 15, 16) responsive to the output of the infra-red detector (10) for disconnecting the power source (7) from the air moving means (6) upon an increase in the said pressure difference on the commencement of exhalation.

5. Breathing apparatus according to Claim 4 characterised in that the control means (14, 15, 16) includes a relay (16) operable when the said pressure difference increases above a predetermined level to disconnect the power source (7) driving the air moving means (6).

6. Breathing apparatus according to any one of Claims to 5 characterised in that the air moving means (6) is a fan.

7. Breathing apparatus according to Claim 6 characterised in that the fan (6) is a centrifugal fan.

8. A positive pressure filter respirator comprising a full face mask including:

a) an outer mask (1) for engaging the head of a wearer to exclude noxious atmospheric gases from a region within the outer mask (1),

b) an orinasal mask (2) within the outer mask (1) and engaging the face of the wearer to surround his respiratory passages,

c) an inhale valve (8) mounted in the orinasal mask (2) and operable to connect the interior of the orinasal mask (2) with the space (20) within the outer mask (1) and outside the orinasal mask (2),

d) an exhale valve mounted in the orinasal mask (2) and operable to connect the interior of the orinasal mask (2) direct to the ambient atmosphere,

e) an air inlet (4) to the outer mask (1),

f) a filter (5) mounted to the outer mask (1) to filter air passing through the air inlet (4),

g) a fan (6) located in the space (20) within the outer mask (1) and outside the orinasal mask (2) for moving air through the filter (5) into the outer mask (1) to establish a pressure above ambient pressure within the outer mask (1) and outside the orinasal mask (2), and,

h) a fan motor (7) for driving the fan (6) to move air through the filter (5),

characterised in that there is provided:

i) detector means (9, 10) located within the orinasal mask (2) for detecting an increase in gas pressure within the orinasal mask (2) relative to the gas pressure in the outer mask (1) consequent upon exhalation by the wearer, and

j) control means (14, 15, 16) responsive to detection of the said increase in gas pressure within the orinasal mask (2) by the detector means (9, 10) for disabling the fan motor (7).

9. A positive pressure filter respirator according to Claim 8 characterised in that the detector means (9, 10) comprises a diaphragm (9) and an infra-red proximity detector (10) mounted near one another within the orinasal mask (2), the infra-red proximity detector (10) giving an output dependent on the position adopted by the diaphragm (9) in response to the difference in pressure between the gas pressure within the orinasal mask (2) and the gas pressure within the outer mask (1).

10. A positive pressure filter respirator according to Claim 8, characterised in that a signal given by the detector means (10) is utilised by a voltage comparator (15) of the control means to disable the fan motor (7) upon detection of a predetermined increase in the gas pressure within the orinasal mask (2) relative to the gas pressure in the outer mask (1).

FIG.1.

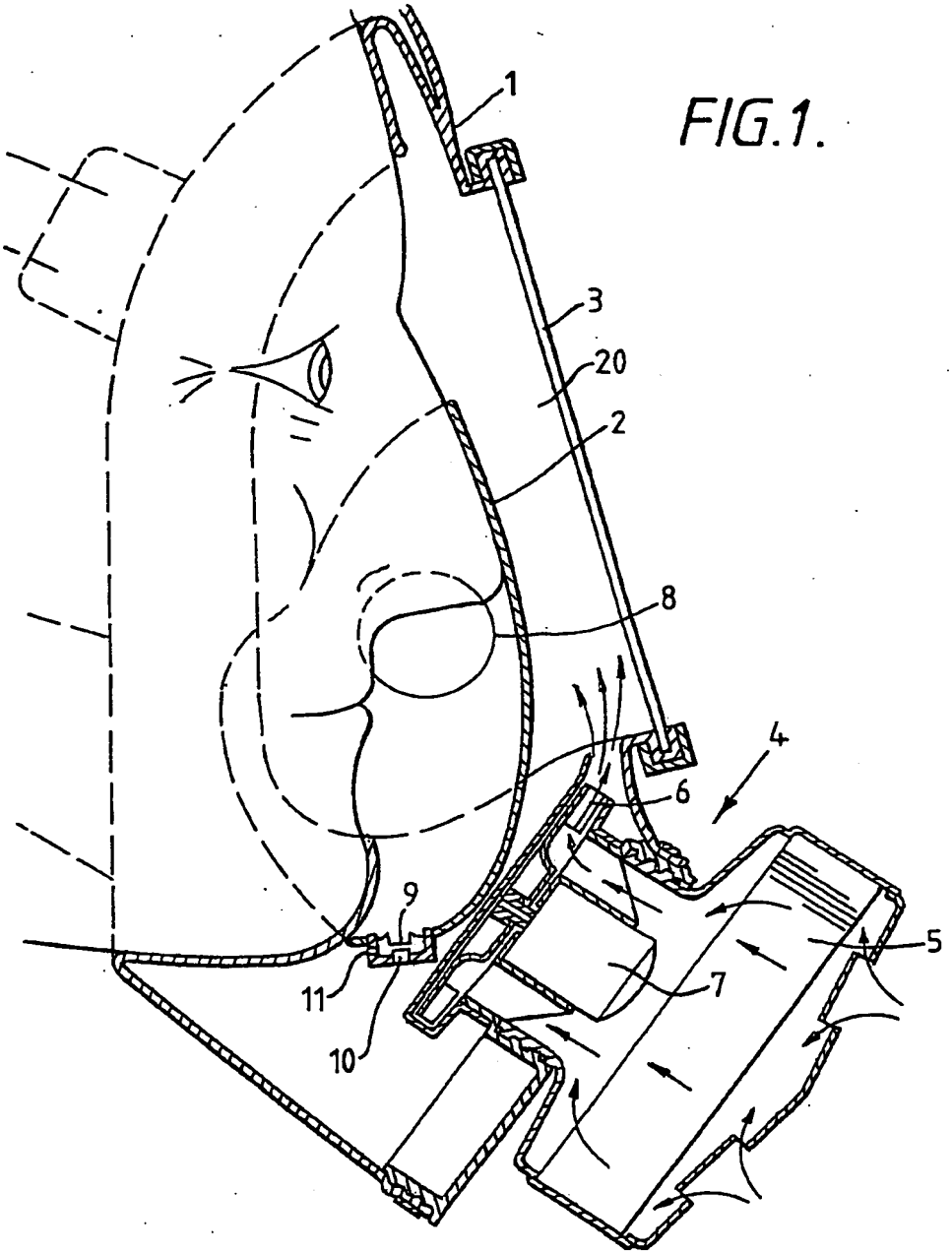

FIG. 2.